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WELDING LARGE METAL STRUCTURES

Many small metal structures are being welded, but whether or not a steel bridge or the framework of a skyscraper can be welded economically is another question.

The American Bureau of Welding, 29 West Thirty-ninth Street, New York N. Y., is planning an extensive investigation of welded steel structures. James H. Edwards, assistant chief engineer of the American Bridge Co., 71 Broadway, New York, N. Y., one of the directors of the American Bureau of Welding, is interested in this method of fabrication, which may have many advantages over riveting.

Electric arc welding was used by Mr. Edwards's company to fabricate some steel plates in order to determine the difficulties which might arise in using this process. The result was a plate girder 15 feet long, having a web plate one-half inch thick and 24 inches deep. The flanges were 12 inches wide, one 1¾ and the other 1⅞ inches thick. A cover plate 9½ inches wide and nearly as thick as the flange was used on the top and the bottom flanges. Nine stiffeners on each side were welded to both flanges and the web.

To determine the strength of this structure, particularly whether or not the welds were satisfactory, it was tested by the Bureau of Standards in cooperation with the American Bridge Co. The Olsen hydraulic machine, having a capacity of 10,000,000 pounds, was used, loading the girder at the middle of a 13½-foot span. The engineers of the bridge company estimated that if the welds were sufficiently strong to develop the full strength of the web the girder would carry a load of about 410 tons.

It was gratifying to find that the maximum load was somewhat greater than this estimate, and that the welds connecting the web to the top flange failed at the ends only after the web was buckled and the girder had deflected several inches.

The investigation which is to be undertaken by the American Bureau of Welding will be planned to secure fundamental data which will enable an engineer to design safe welded structures. It is probable that a saving in the cost of steel structures will be one of the advantages of using this new method of fabrication.

FIBER WALL BOARD

At the request of the Federal Specifications Board the bureau, through a special research, is assisting in the development of a purchase specification for fiber wall board. Ten manufacturers are cooperating in this work by supplying authentic samples of their products and acting in an advisory capacity. Fiber wall board is composed of vegetable fibers made water resistant by the incorporation of rosin or other sizing materials, and, in addition, the surfaces are sometimes treated with water-resistant varnishes or oils. There are two types available—the laminated board, consisting of several plies bound together by a

suitable adhesive, such as sodium silicate, and the homogeneous board which is a one-piece product. In respect to dimensions, the manufacturing practice regarding length and width is quite uniform, most of the manufacturers supplying boards 32 and 48 inches wide and 6 to 16 feet in length in even feet. The laminated board is usually supplied in two thicknesses — three-sixteenths and one-fourth inch. The thickness of the homogeneous type is more variable and generally greater than that of the laminated type, running up to seven-sixteenths inch. The weight ranges from 350 to 675 pounds for the laminated type and 600 to 1,100 pounds for the homogeneous type per 1,000 square feet.

While the bursting strength is quite commonly taken as a measure of the resistance of the board to strains incident to usage, the research made in this direction indicates that a better measure, more in line with service conditions, is obtained by a flexural strength test. The method consists of suspending a strip of the board on two parallel rods and applying an increasing load at the center of the strip through a rod placed across the top parallel to the other rods until the board breaks. The load required to break various boards, using a 3-inch strip, varied from 7 to 18 pounds per three-sixteenths-inch thickness for the weaker direction of the boards.

An important consideration is the possibility of the board warping after erection, as the result of expansion caused by absorption of moisture from the surrounding atmosphere. This can be determined by immersing the board in water for a short period. Experiments are in progress to find if this method of test gives adequate information as to the liability of the board to warp. The results so far obtained indicate that it does not. A simple extensometer was so designed that several specimens at a time could be tested for degree of expansion by measuring the expansion upon subjecting them to a moisture-saturated atmosphere. The actual expansion of various boards so far tested does not correspond with the amount of water they absorb when subjected to the immersion test. Additional data are being obtained on this point, and it is believed that when they are available an adequate specification can be recommended.

REMOVAL OF STAINS FROM MARBLE

In connection with the research work on various problems for the marble industry a study is being made to determine methods for removing different kinds of stains from marblework. Iron, tobacco, and ink stains are the more common types found on interior marble, and treatments for such have been found which are fairly successful.

Iron stains sometimes occur where contact takes place between the marble and steel work in the structure. An effective treatment for this type of stain consists in applying a solution of sodium citrate followed by sodium hydrosulphite in the dry form and covered with a paste made of whiting and water.

Tobacco stains can usually be removed by a poultice of whiting, soap solution, and sodium carbonate solution. A somewhat more effective treatment consists of chlorinated lime, trisodium phosphate, and water mixed into a poultice with powdered talc.

Inks are of many compositions, and hence the treatment for stains from different inks has to be varied accordingly. Stains from ordinary writing inks can usually be removed by a poultice made of whiting and a strong solution of sodium perborate, followed by a few applications of a sodium citrate solution. Dye inks may be treated by the sodium perborate poultice or by a poultice made of equal parts of chlorinated lime and whiting mixed to a paste with water. Indelible ink stains may be treated like those from dye inks, followed by a few applications of strong ammonia water.

A poultice used on any type of stain should be left on the marble until dry.

Frequently it will be found necessary to repeat such applications a few times to remove the stain entirely.

EXPANSION OF GYPSUM

When calcined gypsum is mixed with water in the usual manner it becomes hard or sets. This setting process is usually accompanied by a change in volume which may be either an expansion or a contraction, but is usually the former. This property is important in making gypsum casts, as it causes the material to fill the crevices of the mold, resulting in clean-cut castings. Furthermore, expansion plays an important part in the adhesion of gypsum plasters to certain backings. It is well known that gypsum plaster having a minimum expansion on setting has a maximum adhesion to concrete. It is desirable to control the expansion in such cases, and consequently a study of the factors affecting this property of calcined gypsum has recently been undertaken at the bureau. The material to be measured is cast in specimens approximately 13 by 1 by 1 inches, and the linear changes on setting are followed by means of a microscopic comparator.

A series of specimens made from normally calcined gypsum mixed with varying amounts of water has been made and the resulting expansions measured. These results show that the expansion varies inversely with the amount of mixing water. Samples mixed with 47.5 per cent water gave an average linear expansion of 0.173 per cent, while those mixed with 55.0 per cent water expanded 0.096 per cent, with intermediate mixes in proportion. Further work in which the fineness of the gypsum, time of set, and method of calcination are varied is in progress.

CLAY-DRYING INVESTIGATION

In accordance with observations and conclusions based on data secured during the early part of the clay-drying investigation, the later and most successful tests have been made, following a schedule of temperature and relative humidity values and changes expressed by the following equations:

$$T = 35 + \frac{p^2}{110}$$

$$\text{Per cent } R.\,H. = 73 - \frac{p^2}{120}$$

where T=dryer temperature in °C.
$R.\,H.$=relative humidity,
p=the already passed percentage of the whole contemplated drying period from start at room temperature to time of reading 110° C. and 5 per cent $R.\,H.$

NOTE.—Varying from the above equations, T was preferably kept to 110° C. as a maximum, while it was not found practicable to run R. H. below about 4 per cent.

In these drying tests, following the above-mentioned schedules of temperature and relative humidity and using bricks 2.5 by 4.5 by 10 inches, it was found possible to dry some clays (a Dennison surface clay, a red-burning Peoria shale, a Canton shale, and a Veedersburg hard blue shale) in four to seven hours without more than negligible drying injuries.

Other clays (including a surface clay, a Lewis run shale, and a Louisville blue shale) required 12 to 15 hours for satisfactory drying; while one, a fire clay, required 20 hours; and two, a "fire clay" and a Kittanning shale "fire clay," required 30 hours each. One "low-grade fire clay" was not successfully dried in 30 hours.

Both theoretical considerations and laboratory observations thus far made in the clay-drying investigation indicate that the clay properties tending to minimize drying injuries are:

1. A low drying shrinkage.

2. A high elastic rupture limit for the partially dried surface layer of the drying clay body. This differs from the so-called "modulus of rupture" in that we are here concerned, not with the tensile strength of the material, but only with the amount of distortion or strain which the partially dried clay will stand before rupture.

Recent comparison tests on an easy drying clay and on a clay very difficult to dry satisfactorily show that, at the stage where 60 per cent of the water of

plasticity has been evaporated, the ratio of per cent shrinkage to allowable safe strain in the easy drying clay is only about two-thirds of the value of that ratio as found for the difficult drying clay.

3. A high water conductivity, and, hence, relatively low water concentration and shrinkage gradients.

PHYSICAL PROPERTIES OF ENGLISH CHINA CLAYS

The bureau at its Columbus (Ohio) branch is engaged in studying the properties of a number of china clays from England. Through a long period of time the ceramic industry has believed that china clays of English origin are in many respects superior to those of domestic origin. Having completed an extended investigation of domestic china clays, the present one, dealing with English clays, was taken up.

The calculation of the physical properties of the unfired clays has been made, as well as the porosity, bulk specific gravity, and volume shrinkage of the fired clays at cones 3, 5, 8, 11, and 14. The results vary as follows:

Unfired clays

Properties	Variation
	Per cent
Water of plasticity	36. 7–47. 5
Volume drying shrinkage	13. 1–23. 8
Shrinkage water	5. 6–16. 7
Pore water	25. 9–37. 4
Bulk (specific gravity)	1. 34–1. 56

The fired properties vary as follows:

Cone No.	Variation in—		
	Porosity	Bulk (specific gravity)	Volume shrinkage
	Per cent		*Per cent*
3	35. 6–46. 7	1. 55–1. 70	15. 8–25. 2
5	28. 6–40. 8	1. 63–1. 85	22. 0–32. 7
8	23. 9–34. 2	1. 83–2. 01	26. 7–39. 4
11	9. 9–23. 2	2. 03–2. 37	36. 8–45. 9
14	. 2–10. 2	2. 29–2. 60	43–5–53. 9

The hydrogen ion, deflacculation, and flocculation relations are now being studied. The standardization of apparatus, buffer check solutions, and method have been completed. When the amount of NaOH required for maximum deflocculation for each clay has been determined, the problem of particle size will be taken up. The literature has been surveyed and it is expected that the method used by Schramm, which is an adaption of that of Oden, will be used.

FLOTATION OF ENAMELS

The work in studying the flotation of enamel slips by means of the capillary viscometer has been continued, and after trial of various sizes and lengths of capillaries and feed tubes a combination has been selected which seems satisfactory for testing slips covering the whole commercial range of consistency.

As the simplest way of showing relative yield value and mobility for factory-control work, rate of flow was plotted against the height of enamel slip in the apparatus.

That this method is capable of distinguishing between slips of different consistencies is shown by the following tabulated results, obtained in a factory:

Enamel and use	Relative yield value	Relative mobility
Ground coat for dipping small pieces	9.5	1.11
Ground coat for dipping large pieces	12.0	.96
White coat for "slushing" small pieces	18.6	.98
White coat for "slushing" large pieces	24.3	.81
White coat for spraying	32.0	.74
Blue cover enamel for spraying	14.5	.38
Blue cover enamel special adjusted	10.5	1.04

The blue spraying enamel had such low mobility that it was adjusted for test purposes. After adjustment the slip was more mobile and had much less tendency to clog the spray gun.

This instance illustrates the commercial value of the described test, for without it the nature of the defect in consistency would remain unknown. It could, therefore, be corrected only by cut and try methods.

ZINC OXIDE AND "SEEDS" IN BOROSILICATE CROWN GLASS

Borosilicate crown glass is employed quite extensively for making the reflecting prisms used in optical instruments, such as range finders and periscopes, and it is also becoming popular for lenses and optical windows, and flats on which graduations or scales are ruled.

For some of these purposes the glass must have an index of refraction of approximately 1.517, and it must be absolutely free from even small bubbles or "seeds," as they are called. At times considerable difficulty is experienced in obtaining glass of the desired quality and in satisfactory quantities.

This kind of glass, free from seeds, has been made repeatedly in the bureau's experimental glass plant, but the index of refraction is somewhat higher (1.520 to 1.523) than desired (1.517). In an effort to obtain a glass with the desired index of refraction the zinc oxide was eliminated from the batch, and although this gave the desired refractive index the glass was almost invariably "seedy." Although numerous changes were made in the temperature of the melting furnace, the length of time allowed for melting and fining, and the method of stirring, it was apparently impossible to make a "seedless" glass. As soon, however, as about 2 per cent of zinc oxide was added to the batch the seeds disappeared, but the refractive index increased.

From this it seems that a reduction of the index of refraction by eliminating zinc oxide can only be made at the expense of the quality of the glass. The bureau's next step will be to reduce the quantity of barium oxide to see if this change will give both the desired quality and optical constants.

The following table gives the index of refraction (N_d), dispersion (V), and the ratios between the percentages of silica, barium oxide, and zinc oxide (the alkalies and boric oxide being practically constant) of four borosilicate crown glasses, the first of which contains no seeds, the others being practically useless because they were too "seedy."

Glass No.	N_d	V	SiO_2 : BaO : ZnO
1	1.5230	63.5	1 : 0.040 : 0.040
2	1.5186	64.1	1 : .041 : .016
3	1.5169	64.6	1 : .040 : [1].004
4	1.5176	64.7	1 : .037 : [1].011

[1] The zinc oxide indicated was derived from the "cullet" used in starting the melt.

THE MAKING OF AN ABSOLUTELY FLAT SURFACE

As the result of extreme skill in polishing and measurement, the bureau now possesses three standards of planeness of unequaled accuracy. These standards are in the form of circular disks of fused quartz from 10 to 11 inches in diameter and 1½ to 2 inches thick. Silica glass, or fused quartz, possesses a great advantage over glass for a standard of this kind because of its low coefficient of expansion (about one-fifteenth that of glass). The disks were purchased by the bureau and were roughed into form in the optical shop. They were then brought to a high state of precision as optically true planes by hand polishing on a circular pedestal, which permitted the operator to move freely around it as he swept the disk in ever-varying loops or turns over the polishing plate.

The three disks were ground on each other until both faces were as flat as a straight line would reveal. The surfaces were then carefully inspected to discover any bubbles, which if not reamed out might chip off at the edges and cause scratches during the polishing process.

The polishing was carried out in three stages. The first process gave a high-grade polish on both faces of the three disks, no flatness tests being made. The second brought one face of each disk to planeness as nearly perfect as ordinary tests with the working (glass) standard would reliably indicate. The test was made by bringing the surfaces of the quartz disk and the glass standard together and observing the straightness of the system of interference fringes produced when monochromatic light fell upon the surfaces.

At the beginning of the third stage of polishing tests were made with a "Pulfrich instrument," which provides for viewing the fringes over the entire disk in a perpendicular direction. An initial comparison of each of the three surfaces with reference to a fourth, known to be nearly plane, revealed certain uneven places on the surfaces of the disks, the order of variation, however, being only about 0.6 wave length.

The final polishing operations resulted in surfaces which the most careful tests show differ from a true plane by less than one one-hundredth wave length (two ten-millionths of an inch). "It is one of those rare accomplishments in which the craftsman has worked with a degree of precision equal to that with which the laboratoriam can measure."

Should these disks prove to be permanent in form, which time alone can reveal, the bureau will be provided with a permanent self-checking standard of planeness, with an accuracy adequate to meet all demands.

A more complete description of this achievement, with illustrations, will be found in an article by C. A. Skinner entitled "Making a Standard of Planeness" in the General Electric Review, Volume XXIX, No. 8, p. 528; August, 1926.

WEARING TEST FOR PLUG GAUGES

A machine has been devised and built by the bureau for studying and testing the wear of plug gauges. Its operation is essentially a duplication of the "ringing action" commonly used while gauging under actual service conditions. The gauges are operated vertically with a "pistonlike" effect at an approximate rate of 1,300 strokes per hour (one up and one down movement is equal to one stroke.) The gauged specimen is a split ring which is held together under fixed pressure, thereby insuring uniform conditions of test. This ring is rotated horizontally at about 900 revolutions per hour.

The gauges were tested under conditions termed "metal to metal wear" and "abrasion wear." In the former case a 1 per cent potassium dichromate solution (approximately one-thirteenth normail) was used to keep the gauges cool and to prevent the formation of oxide between the ring and gauge. The abrasive used consisted of a mixture of 25 grams of 303-mesh emery with 1 liter

of lard oil, which was continuously fed in between the gauge and ring.

Chromium-plated gauges were found superior in wear resistance, under the service conditions studied, to gauges made of the customary or special gauge steels.

Under "metal to metal wear" conditions chromium-plated gauges showed about 500 per cent greater wear resistance than that shown by the better of the commonly used gauge materials which were tested, while under "abrasive-wear" conditions they excelled by about 35 per cent in wear resistance. They also have the advantage that a machinable base metal may be chosen upon which to plate the hard, wear-resistant chromium; they are not subject to dimensional changes encountered in hardening the customary gauge steels, and do not then change in dimensions with time.

It was also shown for some of the customary gauge steels that file hardness is not an indication of best wear resistance.

PAINTING OF STRUCTURES TO PREVENT SUPERHEATING

The bureau was consulted recently about a method for preventing the superheating of gas balloons in sunlight. It will be remembered that some time ago the bureau investigated the heat radiated by various substances when covered with different kinds of paint. The experience gained in this work helped in the solution of the present problem. To reduce the heating of the interior of the balloon, the outer surface of the top and sides of the outer shell should be painted white to reduce the heating by reflecting the sunlight. On the inside of the outer shell the top and sides should be painted with aluminum paint to prevent heat radiation into the interior. The tops of the balloonettes containing the gas should be covered with aluminum paint to reflect the low-temperature radiation emanating from the inside of the outer envelope. The whole underside of the balloon should be covered with a nonmetallic paint to accelerate the cooling of the interior.

The same general procedure is, of course, applicable to the painting of other structures to prevent superheating.

EFFECT OF DRY CLEANING ON SILK

A study of the effect of dry cleaning and some service conditions on the strength of weighted and unweighted silk materials, one of the projects of the research associateship of the National Association of Dyers and Cleaners, has recently been completed.

Samples of unweighted and weighted silks were exposed to sunlight and others were stored at standard conditions (of 65 per cent relative humidity at 70° F. temperature) after various treatments, which included perspiration, dry-cleaning solvents, and ironing. The following conclusions were drawn:

1. No deterioration results from exposures to standard atmospheric conditions over a period of two and one-half months, even when acid or alkaline perspirations are applied.

2. Sunlight exposure causes a marked deterioration in both unweighted (but dyed) and tin-weighted silks, the loss in strength in 100 hours' exposure amounting to about 25 per cent for unweighted and about 50 to 75 per cent for weighted silks.

3. Acid and alkaline perspiration treatments increase the deterioration when sunlight exposures are given, so that the loss in strength in 100 hours' exposure is about 35 per cent for unweighted and about 65 to 100 per cent for weighted silk.

4. One undyed weighted sample showed similar disintegration as the dyed samples.

5. Dry-cleaning solvents in no case caused any appreciable deterioration of the silk fabrics.

The fact that the equivalent of the exposure given in this study may require six months to several years to equal it in actual usage indicates that no particular alarm need be felt, for in all probability the garment will be out of

service either because of style changes or actual abrasive wear before sufficient disintegration has taken place to impair its usefulness. Occasionally these deteriorated garments occur, however, and in the large number of garments handled by the dry-cleaning industry they provide a source of trouble and generally expense.

This study is reported in full in Technologic Paper No. 322, now in press, and which will soon be available by purchase from the Superintendent of Documents, Government Printing Office, Washington, D. C.

A NEW TEST FOR MOTOR FUELS

At the present time one of the chief specifications for gasoline is based upon what are known as Engler distillation tests, in which, under specified conditions of heating, etc., temperatures at which definite percentages of fuel are evaporated are noted. As a "thumbprint" type of test the Engler distillation is highly satisfactory, in that it furnishes an excellent means for identifying the fuel. It does more than this, however. It provides a basis for estimating the relative vaporization characteristics of fuels. Thumbprints and knowledge that one man is taller or fatter than another are by no means sufficient information for the tailor who must provide the man with a suit which will fit. Similarly, accurate means for identifying a fuel and knowledge that it is more or less volatile than another fuel are scarcely adequate data for the engineer who must "fit" the motor-car fuel with a suitable carbureter and manifold.

The present type of distillation test fails to give this information, because the fuel is vaporized under conditions very different from those which prevail in the manifold of an internal-combustion engine. In the August issue of the Journal of the Society of Automotive Engineers T. S. Sligh describes a new test of automobile fuels which is being developed at the Bureau of Standards. Although this, too, is a distillation test, the conditions under which the fuel is vaporized are approximately those which exist in the intake system of the ordinary internal-combustion engine. In this test air is caused to flow through a helical metal tube at a predetermined rate as measured by a small orifice meter. Fuel is supplied at a predetermined rate by displacement from a reservoir governed by a clock-controlled cylinder. Unevaporated fuel is drained from the lower end of the helix and measured. The temperature of the fuel-air mixture is controlled and varied as desired.

Further work is being done in adapting this apparatus to laboratory use, and it is expected that the device will materially assist the automotive engineer by providing him with information as to the temperatures and mixture ratios necessary for the efficient utilization of a given fuel.

RECORDING GAS CALORIMETERS

Some 12 years ago the bureau published the results of an investigation of calorimeters for determining the heating value of gas. (Technologic Paper No. 36, 40 cents.) The investigation indicated that the water-flow type of instrument was suitable for the purpose, and instructions for operating such instruments were subsequently issued by the bureau. The water-flow calorimeter is now accepted as the standard instrument in the gas industry both for purposes of regulation and sale and for control of the manufacturing process. In many instances hourly tests of heating value are made. In such cases a recording calorimeter would obviously be useful, and many types of recorders have been proposed. Recently, when it was decided to undertake an investigation of recording calorimeters, which was to be limited to instruments which were actually in use to some extent, excluding those in the experimental or development stage, it appeared that under these conditions

the test would include only one instrument. Although the situation was unique, it was decided to proceed with the test of the one instrument. The purpose of this note is to bring the situation to the attention of any who may be interested. Results will evidently not be available for some time, but as soon as they are announcement will be made through this bulletin.

REVISION OF CIRCULAR NO. 17 ON MAGNETIC TESTING

Considerable progress has been made in methods of magnetic testing since the last edition of Circular No. 17 on magnetic testing was issued in 1916. A new revision of this circular has been prepared describing the latest methods of magnetic testing in use by the bureau. This revision is now in press.

AUGUST, 1926, PUBLICATIONS

Additions to "Supplementary List of Publications of the Bureau of Standards" (Beginning July 1, 1925)

Scientific Papers [1]

S528. Experimental study of the relation between intermittent and nonintermittent sector-wheel photographic exposures; Raymond Davis. Price, 20 cents.

Circulars [1]

C304. Properties and manufacture of concrete building units. Price, 20 cents.

Miscellaneous Publications [1]

M39 (3d ed.) (card). Household weights and measures. Price, 5 cents.

Simplified-Practice Recommendations [1]

(Elimination of Waste)

R39. Dining-car chinaware. Price, 5 cents.

R41. Package sizes for insecticides and fungicides. Price, 5 cents.

Technical News Bulletin [2]

TNB 112. Technical News Bulletin, August, 1926.

OUTSIDE PUBLICATIONS

The annealing of glass, a nontechnical presentation. A. N. Finn; Journal, American Ceramic Society, vol. 9, No. 8, p. 493; August, 1926.

Some effects of hydrogen on iron and their bearing on a reported transformation at 370° C. H. S. Rawdon, P. Hidnert, and W. A. Tucker; Transactions, American Society for Steel Treating, vol. 10, p. 233; 1926.

Silicon as an alloy in steel. H. W. Gillett; Iron Age, vol. 118, p. 481; 1926.

Wear of steels with particular reference to plug gauges. H. J. French and H. K. Herschman; Preprint for presentation at American Society for Steel Treating convention, Chicago; September 20, 1926.

Making a standard of planeness. C. A. Skinner; General Electric Review, Vol. XXIX, No. 8, p. 528; August, 1926.

Safety in a gasoline-engine research laboratory. R. N. Du Bois; Safety Engineering, p. 27, July, 1926.

Volatility test for automobile fuels. T. S. Sligh, jr.; Journal, Society of Automotive Engineers, Vol. XIX, No. 2, p. 151; August, 1926; Oil and Gas Journal, p. 72, August 12, 1926.

Making airships safe. L. B. Tuckerman; The Scientific Monthly, Vol. XXIII, p. 74, July, 1926.

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